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Bibliography and Index on Dynamic Pressure Measurement

W. G. Brombacher and T. W. Lashof

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PREFACE

This bibliography and index on dynamic pressure measurement is one of a series of reports intended to summarize the state-of-the-art in various areas of the field of instrumentation. These reports are the results of surveys conducted as part of a program of instrumentation research and development which is cooperatively sponsored at the National Bureau of Standards by the Atomic Energy Commission, the Office of Naval Research and the Air Research and Development Command. This program is administered by the Office of Basic Instrumentation, W. A. Wildhack, Chief.

It has been the aim in these surveys to include critical evaluation and organization of the available information. In dealing with the broad area of dynamic pressure measurements it was considered desirable to limit the scope of the initial work to the preparation of a bibliography. The references have been extensively indexed and classified by subject and author to assist the user in the task of making detailed analyses with respect to his particular interest. The bibliography may also serve as the starting point for more detailed surveys of more specialized parts of the subject.

The work on this project was conducted in the Mechanics Division, Walter Ramberg, Chief, under the direct supervision of E. C. Lloyd, Chief of the Mechanical Instruments Section.

A. V. Astin
Director

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BIBLIOGRAPHY AND INDEX ON DYNAMIC PRESSURE MEASUREMENT

W. G. Brombacher and T. W. Lashof

This circular contains a bibliography of 850 items on dynamic pressure measurement and, in less detail, on related subjects such as static pressure measurement and general information on the components of instruments. An index of the bibliography by both subject and author is included.

1. INTRODUCTION

1.1. Scope of Bibliography

A number of decisions had to be made on the scope of this bibliography. These included (a) the applications to be included, (b) the degree that so-called static instrumentation should be covered, and (c) the extent that design parameters should be included. Obviously coverage could not be complete in any of these cases, without increasing inordinately the size of the bibliography and the labor.

At this point a definition of dynamic instrumentation will be ventured. If a measurement can be made, while the pressure (or other quantity) is changing, even very slowly, the instrument for that measurement is a dynamic instrument. It is assumed here that corrections for lag and other factors can be made so that a true value of pressure (or other quantity) can be deduced. Under this definition many instruments ordinarily classed as "static", including liquid columns and piston gages, may be "dynamic" for low rates of change of pressure, if means for securing dynamic reading are devised.

Thus, pressure instrumentation cannot be divided uniquely into static and dynamic types for all possible applications. An instrument "too slow" for a particular application may be classed by the engineer as good only for static measurement, while for another application the same instrument may be classed as dynamic. From this viewpoint it seemed reasonable to include some references in the bibliography on instrumentation ordinarily classed as suitable only for static measurements. Another point considered in including references to static instrumentation was usefulness of such instruments as a standard in making static calibrations of dynamic instruments.

There was some question as to how far to go in including references on basic design and performance factors. A limited number of references are given on such quantities as drift or creep, hysteresis, temperature coefficient of elasticity, on important diaphragm and electrical resistance materials, on piezoelectric materials and on seals and solders. There are probably significant omissions and on most of these subsidiary subjects the coverage is far from complete.

The fields of application covered in the bibliography include blast pressures, underwater explosions, automotive powerplants, ballistics, meteorology, aeronautics, and physiology. Less well covered, but perhaps adequately for an introduction to the field, are applications in acoustics, geophysics, industrial and miscellaneous explosions, hydraulics, structures, high pressure and high vacuum.

Pressure measuring instrumentation and associated factors are outlined below in order to give an indication of the coverage in the bibliography.

a. Pressure Sensing Elements

(a) Crusher gages, indenter gages, rupture disks, and permanently deformed diaphragms or other shaped structures form a class which without additional mechanism, are direct indicators or recorders of a dynamic pressure, usually in the nature of a shock.

(b) Diaphragms in their various forms, bellows, Bourdon tubes, bells, and cylinders and pistons form a class of pressure sensing elements of which the deflection, converted to an indication or record by mechanical, optical, or electrical means, is a measure of a pressure change. Of these, diaphragms, bellows, and pistons and cylinders, are commonly used for dynamic measurement to the limit of their utility.

(c) Piezoelectric crystals, pressure sensitive electrical resistors (liquid or solid), and electro-kinetic pickups form a class of sensing elements the output of which under a dynamic change in pressure is electrical in nature. This output is converted to a usable indication or record by suitable electrical circuits. Hot-wire and ionization vacuum gages fall into this class also, but are suitable only for essentially static measurements; accordingly, only a few references on them are listed in the bibliography.

(d) Optical pressure sensing elements are indirect in nature; the phenomena occurring in a gas are photographed so as to obtain spectra or diffraction effects from which the pressure is deduced. The application is largely in aeronautics.

(e) Primary sensing elements, not falling into any of the above classes, include a combination of a vibrating wire and diaphragm capsule "Vibratron", and vapor pressure from a boiling liquid or subliming solid in equilibrium with the gas the pressure of which is to be measured, with sensing by a thermometer (hypsometer).

b. Transducers

Transducers may be divided into three types:

(a) A first type includes the types of pickups or transducers which convert the deflections of selected primary sensing elements listed in paragraph 1 (b) above to an electrical signal which is usually amplified to give a usable indication or record. Commonly a diaphragm is used as the primary element. Transducers include the following types: capacitance, inductance in its various forms, potentiometer, resistance wire strain gages, self generator of a voltage, photoelectric tube, vacuum tube (controlling position of the grid or plate), magnetostriction, electrical contact (for pressure balance), frequency (of vibrating wire), and most of that class of pickups called microphones which for the most part fall into one of the types of pickups just listed.

(b) A second type are pickups or transducers for converting the deflections of the primary sensing elements listed in paragraph 1 (b) above to an indication, or record, essentially by optical means, excluding electrical indication or recording. These are principally the optical lever and the interferometer.

(c) Mechanical pickups associated with a number of the primary sensing elements listed in paragraph 1 (b) form the third class which includes the common pressure gage. These include mechanical multiplying linkages, pressure-pressure balance, force-pressure balance and scales (for liquid columns). This class has limited application in dynamic instrumentation.

c. Auxiliary Apparatus

This includes amplifiers, electrical circuits and circuit elements, timers, indicators, recording methods and telemetering, largely for the primary elements, paragraph 1 (c), and transducers, paragraph 2 (a).

d. Design and Performance Data

Included is the performance of instruments and instrument elements, pressure lag in connecting lines, electrical cable problems, and calibration methods both dynamic and static are all pertinent to dynamic instrumentation, on which coverage is essential.

1.2. Scope and Use of Subject Index

The policy of rather heavy cross indexing was followed in two directions. First, to aid the user, synonyms and differences in technical nomenclature and cross referenced insofar as known to the authors. For example, papers covering pressure lag in liquid and pneumatic lines are listed under "Lag, fluid lines" and cross-indexed under Lines; Pneumatic lines: Pipe-line lag; Pressure lag in lines; and Tubing, connecting, pressure lag. In spite of all efforts, completeness has not been achieved.

Second, each paper and report on instrumentation, as applicable, is listed under the application, the primary sensing element, the transducer, the electrical circuit, and where significant, under the recording means. Under the heading "Frequency response data", some papers and reports are listed in which experimental data on frequency response or natural frequency are given.

It was found impractical to do more than indicate the topics covered in a paper, and in many cases incompletely. Books on subjects not directly concerned with pressure measurement, such as those on circuits or magnetism, are not indexed in any detail, usually only under "Books and surveys" and under the subject of the book.

Under the heading "Bibliographies" are also listed papers which contain at least 20 pertinent references. "Books and surveys" and "Symposia" are also listed under the applicable heading.

Since many of the unpublished reports will be difficult to locate, it is worthwhile to use the subject index to determine roughly the scope of those containing a discussion of instrumentation. Often the title of the report is sufficient. Otherwise the cross indexing feature may be used with profit to determine for example the application, the primary sensing element, the type of transducer, the circuit and the recording method. It can be determined for example from the index whether the paper is a review, and with reasonable assurance whether any frequency response data is included, or if it contains an extensive list of references, by searching under the heading Books and Surveys or under headings suggested by the title of the paper, under Frequency response data, and under Bibliography, respectively.

The authors desire to acknowledge the assistance of Mr. Leo B. Orbach in preparing a substantial part of the bibliography.

2. BIBLIOGRAPHY

The references are divided into a list of books and a list of papers and reports, all listed chronologically, by years. Books are designated by the letter "B" followed by two digits giving the year of publication and by a single digit identifying the order of listing. For example, B524 indicates a book published in 1952, listed fourth under 1952 in the book list. Papers and reports are designated by four digits, the first two indicating the year of publication or issue, and the last two the order of listing. Thus 4956 indicates publication in 1949 and 56th in the list for 1949.

About 850 books, papers and published reports are referenced. On strictly dynamic pressure measurement considerable effort was made to insure complete coverage of published papers from about 1940 to May 1, 1954. A special effort was made to include unpublished, open reports issued by defense agencies and their contractors, and other governmental agencies. Some of these reports have had to be indexed from the title because a copy could not be located. Although some of the topics covered may not be closely related to dynamic pressure measurement, it was decided to cover in the bibliography as many as possible of the various factors affecting the design and performance of dynamic pressure instruments. Coverage of these factors is not intended to be complete.

A few primary papers on static calibration were listed because such calibrations are made on dynamic pressure-measuring instruments in the cases where an indication of static pressure is obtainable.

With minor exceptions neither catalogs, nor announcements in trade journals of new instruments without technical data, are listed. However, references 5235 and B534 supply considerable data on the pressure instrumentation commercially available at the present time.

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